Package ‘ATAforecasting’

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Type Package

Title Automatic Time Series Analysis and Forecasting using the Ata Method

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Description The Ata method (Yapar et al. (2019) <doi:10.15672/hujms.461032>), an alternative to exponential smoothing (described in Yapar (2016) <doi:10.15672/HJMS.201614320580>, Yapar et al. (2017) <doi:10.15672/HJMS.2017.493>), is a new univariate time series forecasting method which provides innovative solutions to issues faced during the initialization and optimization stages of existing forecasting methods. Forecasting performance of the Ata method is superior to existing methods both in terms of easy implementation and accurate forecasting. It can be applied to non-seasonal or seasonal time series which can be decomposed into four components (remainder, level, trend and seasonal). This methodology performed well on the M3 and M4-competition data. This package was written based on Ali Sabri Taylan’s PhD dissertation.

Maintainer Ali Sabri Taylan <alisabritaylan@gmail.com>

License GPL (>= 3)

URL https://github.com/alsabtay/ATAforecasting,
https://atamethod.wordpress.com/

BugReports https://github.com/alsabtay/ATAforecasting/issues

Depends R (>= 4.1)

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Author Ali Sabri Taylan [aut, cre, cph]
(<https://orcid.org/0000-0001-9514-934X>),
Hanife Taylan Selamlar [aut, cph]
(<https://orcid.org/0000-0002-4091-884X>),
Guckan Yapar [aut, ths, cph] (<https://orcid.org/0000-0002-0971-6676>)

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`ATA` *Automatic Time Series Analysis and Forecasting using Ata Method with Box-Cox Power Transformations Family and Seasonal Decomposition Techniques*

Description

`ATA` is a generic function for Ata Method forecasting. The Ata method based on the modified simple exponential smoothing as described in Yapar, G. (2016) <doi:10.15672/HJMS.201614320580> , Yapar G., Capar, S., Selamlar, H. T., Yavuz, I. (2017) <doi:10.15672/HJMS.2017.493> and Yapar G., Selamlar, H. T., Capar, S., Yavuz, I. (2019) <doi:10.15672/hujms.461032> is a new univariate time series forecasting method which provides innovative solutions to issues faced during the initialization and optimization stages of existing methods. Forecasting performance of the Ata method is superior to existing methods both in terms of easy implementation and accurate forecasting. It can be applied to non-seasonal or seasonal time series which can be decomposed into four components (remainder, level, trend and seasonal). This methodology performed well on the M3 and M4-competition data.

Usage

```
ATA(
  X,
  Y = NULL,
  parP = NULL,
  parQ = NULL,
  parPHI = NULL,
  model.type = NULL,
  seasonal.test = NULL,
  seasonal.model = "decomp",
  seasonal.period = NULL,
  seasonal.type = NULL,
  seasonal.test.attr = NULL,
  find.period = NULL,
  accuracy.type = NULL,
  nmse = 3,
  level.fixed = FALSE,
  trend.opt = "none",
  h = NULL,
  train_test_split = NULL,
  holdout = FALSE,
  holdout.adjustedP = TRUE,
  holdout.set_size = NULL,
  holdin = FALSE,
  transform.order = "before",
  transform.method = NULL,
  transform.attr = NULL,
  lambda = NULL,
  shift = 0,
  initial.level = NULL,
  initial.trend = NULL,
  ci.level = 95,
  start.phi = NULL,
  end.phi = NULL,
  size.phi = NULL,
  negative.forecast = TRUE,
  print.out = TRUE,
  plot.out = TRUE
)
```

Arguments

X	A numeric vector or time series of class `ts` or `msts` for in-sample.

Y — A numeric vector or time series of class ts or msts for out-sample. If you do not have out-sample data, you can split in-sample data into training and test dataset with train_test_split argument.

parP — Value of Level parameter p. If NULL or "opt", it is estimated. p has all integer values from 1 to length(X).

parQ — Value of Trend parameter q. If NULL or "opt", it is estimated. q has all integer values from 0 to p.

parPHI — Value of Damping Trend parameter phi. If NULL or "opt", it is estimated. phi has all values from 0 to 1.

model.type — An one-character string identifying method using the framework terminology. The letter "A" for additive model, the letter "M" for multiplicative model. If NULL, both letters will be tried and the best model (according to the accuracy measure accuracy.type) returned.

seasonal.test — Testing for stationary and seasonality. If TRUE, the method firstly uses test="adf", Augmented Dickey-Fuller, unit-root test then the test returns the least number of differences required to pass the test at level alpha. After the unit-root test, seasonal test applies on the stationary X.

seasonal.model — A string identifying method for seasonal decomposition. If NULL, "decomp" method is default. c("none", "decomp", "stl", "stlplus", "tbats", "stR") phrases of methods denote

- none : seasonal decomposition is not required.
- decomp : classical seasonal decomposition. If decomp, the stats package will be used.
- stl : seasonal-trend decomposition procedure based on loess developed by Cleveland et al. (1990). If stl, the stats and forecast packages will be used. Multiple seasonal periods are allowed.
- stlplus : seasonal-trend decomposition procedure based on loess developed by Cleveland et al. (1990). If stlplus, the stlplus package will be used.
- tbats : exponential smoothing state space model with Box-Cox transformation, ARMA errors, trend and seasonal components. as described in De Livera, Hyndman & Snyder (2011). Parallel processing is used by default to speed up the computations. If tbats, the forecast package will be used. Multiple seasonal periods are allowed.
- stR : seasonal-trend decomposition procedure based on regression developed by Dokumentov and Hyndman (2015). If stR, the stR package will be used. Multiple seasonal periods are allowed.
- x13 : seasonal-trend decomposition procedure based on X13ARIMA/SEATS. If x13, the seasonal package will be used.
- x11 : seasonal-trend decomposition procedure based on X11. If x11, the seasonal package will be used.

seasonal.period — Value(s) of seasonal periodicity. If NULL, frequency of X is default If seasonal.period is not integer, X must be msts time series object. c(s1,s2,s3,...) for multiple period. If X has multiple periodicity, "tbats" or "stR" seasonal model have to be selected.

seasonal.type
: An one-character string identifying method for the seasonal component framework. The letter "A" for additive model, the letter "M" for multiplicative model. If NULL, both letters will be tried and the best model (according to the accuracy measure `accuracy.type`) returned. If seasonal decomposition methods except `decomp` with "M", Box-Cox transformation with `lambda`=0 is selected.

seasonal.test.attr
: Attributes set for unit root, seasonality tests, X13ARIMA/SEATS and X11. If NULL, corrgram.tcrit=1.28, uroot.test="adf", suroot.test="correlogram", suroot.uroot=TRUE, uroot.type="trend", uroot.alpha=0.05, suroot.alpha=0.05, uroot.maxd=2, suroot.maxD=1, suroot.m=frequency(X), uroot.pkg="urca", multi.period="min", x13.estimate.maxiter=1500, x13.estimate.tol=1.0e-5, x11.estimate.maxiter=1500, x11.estimate.tol=1.0e-5. If you want to change, please use `ATA.SeasAttr` function and its output. For example, you can use `seasonal.test.attr = ATA.SeasAttr(corrgram.tcrit=` equation in `ATA` function.

find.period
: Find seasonal period(s) automatically. If NULL, 0 is default. When `find.period`,

- 0 : none
- 1 : single period with find.freq
- 2 : single period with `forecast::findfrequency`
- 3 : multiple period with find.freq & stR
- 4 : multiple period with find.freq & tbats
- 5 : multiple period with find.freq & stl

accuracy.type
: Accuracy measure for optimization of the best ATA Method forecasting. IF NULL, `sMAPE` is default.

- lik : maximum likelihood functions
- sigma : residual variance.
- MAE : mean absolute error.
- MSE : mean square error.
- AMSE : Average MSE over first ‘nmse‘ forecast horizons using k-step forecast.
- GAMSE : Average MSE over first ‘nmse‘ forecast horizons using one-step forecast.
- RMSE : root mean squared error.
- MPE : mean percentage error.
- MAPE : mean absolute percentage error.
- sMAPE : symmetric mean absolute percentage error.
- MASE : mean absolute scaled error.
- OWA : overall weighted average of MASE and sMAPE.
- MdAE : median absolute error.
- MdSE : median square error.
- RMdSE : root median squared error.
- MdPE : median percentage error.
- MdAPE : median absolute percentage error.
- sMdAPE : symmetric median absolute percentage error.

nmse
: If accuracy.type == "AMSE" or "GAMSE", nmse provides the number of steps for average multistep MSE (‘2<=nmse<=30‘).

level.fixed
: If TRUE, "pStarQ" –> First, fits ATA(p,0) where p = p* is optimized for q=0. Then, fits ATA(p*,q) where q is optimized for p = p*.

trend.opt
: When `trend.opt`,
  - none : none
  - fixed : "pBullet" –> Fits ATA(p,1) where p = p* is optimized for q = 1.
  - search : "qBullet" –> Fits ATA(p,q) where p = p* is optimized for q = q* (q > 0). Then, fits ATA(p*,q) where q is optimized for p = p*.

h
: The number of steps to forecast ahead. When the parameter is NULL; if the frequency of `X` is 4, the parameter is set to 8; if the frequency of `X` is 12, the parameter is set to 18; the parameter is set to 6 for other cases.

train_test_split
: If `Y` is NULL, this parameter divides `X` into two parts: training set (in-sample) and test set (out-sample). `train_test_split` is number of periods for forecasting and size of test set. If the value is between 0 and 1, percentage of length is active.

holdout
: Default is FALSE. If TRUE, ATA Method uses the holdout forecasting for accuracy measure to select the best model. In holdout forecasting, the last few data points are removed from the data series. The remaining historical data series is called in-sample data (training set), and the holdout data is called validation set (holdout set). If TRUE, holdout.set_size will used for holdout data.

holdout.adjustedP
: Default is TRUE. If TRUE, parP will be adjusted by length of training - validation sets and in-sample set when the holdout forecasting is active.

holdout.set_size
: If `holdout` is TRUE, this parameter will be same as `h` for defining holdout set.

holdin
: Default is FALSE. If TRUE, ATA Method uses the hold-in forecasting for accuracy measure to select the best model. In hold-in forecasting, the last h-length data points are used for accuracy measure.

transform.order
: If "before", Box-Cox transformation family will be applied and then seasonal decomposition techniques will be applied. If "after", seasonal decomposition techniques will be applied and then Box-Cox transformation family will be applied.

transform.method
: Transformation method –> "Box_Cox", "Sqrt", "Reciprocal", "Log", "NegLog", "Modulus", "BickelDoksum", "Manly", "Dual", "YeoJohnson", "GPower", "GLog". If the transformation process needs shift parameter, `ATA.Transform` will calculate required shift parameter automatically.

transform.attr
: Attributes set for Box-Cox transformation. If NULL, bcMethod = "loglik", bcLower = 0, bcUpper = 1, bcBiasAdj = FALSE. If you want to change, please use `ATA.BoxCoxAttr` function and its output.

lambda
: Box-Cox power transformation family parameter. If NULL, data transformed before model is estimated.

`shift`	Box-Cox power transformation family shifting parameter. If NULL, data transformed before model is estimated.
`initial.level`	If NULL, FALSE is default. If FALSE, ATA Method calculates the pth observation in `X` for level. If TRUE, ATA Method calculates average of first p value in `X`for level.
`initial.trend`	If NULL, FALSE is default. If FALSE, ATA Method calculates the qth observation in `X(T)-X(T-1)` for trend. If TRUE, ATA Method calculates average of first q value in `X(T)-X(T-1)` for trend.
`ci.level`	Confidence Interval levels for forecasting.
`start.phi`	Lower boundary for searching `parPHI`.If NULL, 0 is default.
`end.phi`	Upper boundary for searching `parPHI`. If NULL, 1 is is default.
`size.phi`	Increment step for searching `parPHI`. If NULL, the step size will be determined as the value that allows the bounds for the optimised value of `parPHI` to be divided into 20 equal parts.
`negative.forecast`	Negative values are allowed for forecasting. Default value is TRUE. If FALSE, all negative values for forecasting are set to 0.
`print.out`	Default is TRUE. If FALSE, summary of ATA Method is not shown.
`plot.out`	Default is TRUE. If FALSE, graphics of ATA Method are not shown.

Details

Returns ATA(p,q,phi)(E,T,S) applied to `X`.

Value

Returns an object of class `ata`. The generic accessor functions `ATA.Forecast` and `ATA.Accuracy` extract useful features of the value returned by `ATA` and associated functions. `ata` object is a list containing at least the following elements

- actual : The original time series.
- fitted : Fitted values (one-step forecasts). The mean is of the fitted values is calculated over the ensemble.
- level : Estimated level values.
- trend : Estimated trend values.
- residuals : Original values minus fitted values.
- coefp : The weights attached to level observations.
- coefq : The weights attached to trend observations.
- p : Optimum level parameter.
- q : Optimum trend parameter.
- phi : Optimum damped trend parameter.
- model.type: Form of trend.
- h : The number of steps to forecast ahead.

- forecast : Point forecasts as a time series.
- out.sample: Test set as a time series.
- method : The name of the optimum forecasting method as a character string for ATA(P,Q,PHI)(Error,Trend,Season).
- initial.level : Selected initial level values for the time series forecasting method.
- initial.trend : Selected initial trend values for the time series forecasting method.
- level.fixed : A choice of optional level-fixed trended methods.
- trend.opt : A choice of optional trend and level optimized trended methods (none, trend.fixed or trend.search).
- transform.method : Box-Cox power transformation family method –> Box_Cox, Sqrt, Reciprocal, Log, NegLog, Modulus, BickelDoksum, Manly, Dual, YeoJohnson, GPower, GLog.
- transform.order : Define how to apply Box-Cox power transformation techniques, before or after seasonal decomposition.
- lambda : Box-Cox power transformation family parameter.
- shift : Box-Cox power transformation family shifting parameter.
- accuracy.type : Accuracy measure that is chosen for model selection.
- nmse : The number of steps for average multistep MSE.
- accuracy : In and out sample accuracy measures and its descriptives that are calculated for optimum model are given.
- par.specs : Parameter sets for Information Criteria.
- holdout : Holdout forecasting is TRUE or FALSE.
- holdout.training : Training set in holdout forecasting.
- holdout.validation: Validation set in holdout forecasting.
- holdout.forecast : Holdout forecast.
- holdout.accuracy : Accuracy measure chosen for model selection in holdout forecasting.
- holdin : Hold-in forecasting is TRUE or FALSE.
- is.season : Indicates whether it contains seasonal pattern.
- seasonal.model : The name of the selected decomposition method.
- seasonal.type : Form of seasonality.
- seasonal.period : The number of seasonality periods.
- seasonal.index : Weights of seasonality.
- seasonal : Estimated seasonal values.
- seasonal.adjusted : Deseasonalized time series values.
- execution.time : The real and CPU time 'in seconds' spent by the system executing that task, including the time spent executing run-time or system services on its behalf.
- calculation.time : How much real time 'in seconds' the currently running R process has already taken.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

#'Yapar G, Yavuz I, Selamlar HT (2017). "Why and How Does Exponential Smoothing Fail? An In Depth Comparison of ATA-Simple and Simple Exponential Smoothing." *Turkish Journal of Forecasting*, **1**(1), 30–39.

#'Yapar G, Capar S, Selamlar HT, Yavuz I (2018). "Modified Holt's Linear Trend Method." *Hacettepe University Journal of Mathematics and Statistics*, **47**(5), 1394–1403.

#'Yapar G (2018). "Modified simple exponential smoothing." *Hacettepe University Journal of Mathematics and Statistics*, **47**(3), 741–754.

#'Yapar G, Selamlar HT, Capar S, Yavuz I (2019). "ATA method." *Hacettepe Journal of Mathematics and Statistics*, **48**(6), 1838-1844.

See Also

forecast, stlplus, stR, stl, decompose, tbats, seasadj, seasonal.

Examples

```
trainATA <-  head(touristTR, 84)
testATA <- window(touristTR, start = 2015, end = 2016.917)
ata_fit <- ATA(trainATA, h=24, parQ = 1, seasonal.test = TRUE, seasonal.model = "stl")
ata_fc <- ATA.Forecast(ata_fit, out.sample = testATA)
ata_accry <- ATA.Accuracy(ata_fc)
```

ATA.Accuracy — *Accuracy Measures for The ATAforecasting*

Description

Returns ATA(p,q,phi)(E,T,S) applied to 'ata' `object`. Accuracy measures for a forecast model Returns range of summary measures of the forecast accuracy. If `out.sample` is provided, the function measures test set forecast accuracy. If `out.sample` is not provided, the function only produces training set accuracy measures. The measures calculated are:

- lik : maximum likelihood functions
- sigma : residual variance.
- MAE : mean absolute error.
- MSE : mean square error.
- RMSE : root mean squared error.
- MPE : mean percentage error.
- MAPE : mean absolute percentage error.
- sMAPE : symmetric mean absolute percentage error.
- MASE : mean absolute scaled error.
- OWA : overall weighted average of MASE and sMAPE.

- MdAE : median absolute error.
- MdSE : median square error.
- RMdSE : root median squared error.
- MdPE : median percentage error.
- MdAPE : median absolute percentage error.
- sMdAPE : symmetric median absolute percentage error.

Usage

```
ATA.Accuracy(object, out.sample = NULL, print.out = TRUE)
```

Arguments

`object`	An object of class `ata` is required.
`out.sample`	A numeric vector or time series of class `ts` or `msts` for out-sample.
`print.out`	Default is TRUE. If FALSE, summary of ATA Method's accuracy measures is not shown.

Value

Matrix giving forecast accuracy measures.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

#'Hyndman RJ, Koehler AB (2006). "Another look at measures of forecast accuracy." *International Journal of Forecasting*, **22**(4), 679–688.

#'Hyndman RJ, Athanasopoulos G (2019). *Forecasting: principles and practice*. OTexts. https://otexts.com/fpp3/.

See Also

`forecast`, `stlplus`, `stR`, `stl`, `decompose`, `tbats`, `seasadj`.

Examples

```
trainATA <-  head(touristTR, 84)
testATA <- window(touristTR, start = 2015, end = 2016.917)
ata_fit <- ATA(trainATA, h=24, seasonal.test = TRUE, seasonal.model = "decomp")
ata_accuracy <- ATA.Accuracy(ata_fit, testATA)
```

`ATA.BackTransform` *Back Transformation Techniques for The ATAforecasting*

Description

The function provides the applicability of different types of back transformation techniques for the transformed data to which the Ata method will be applied. The `ATA.BackTransform` function works with many different types of inputs.

Usage

```
ATA.BackTransform(X, tMethod, tLambda, tShift, tbiasadj = FALSE, tfvar = NULL)
```

Arguments

`X`	a numeric vector or time series of class `ts` or `msts` for in-sample.
`tMethod`	Box-Cox power transformation family is consist of "Box_Cox", "Sqrt", "Reciprocal", "Log", "NegLog", "Modulus", "BickelDoksum", "Manly", "Dual", "YeoJohnson", "GPower", "GLog" in ATAforecasting package.
`tLambda`	Box-Cox power transformation family parameter. If NULL, data transformed before model is estimated.
`tShift`	Box-Cox power transformation family shifting parameter. If NULL, data transformed before model is estimated.
`tbiasadj`	Use adjusted back-transformed mean for Box-Cox transformations using `forecast::BoxCox`. If transformed data is used to produce forecasts and fitted values, a regular back transformation will result in median forecasts. If tbiasadj is TRUE, an adjustment will be made to produce mean forecasts and fitted values.
`tfvar`	Optional parameter required if tbiasadj=TRUE. Can either be the forecast variance, or a list containing the interval `level`, and the corresponding `upper` and `lower` intervals.

Value

A list object consists of transformation parameters and transformed data. `ATA.Transform` is a list containing at least the following elements:

- trfmX : Transformed data
- tLambda : Box-Cox power transformation family parameter
- tShift : Box-Cox power transformation family shifting parameter

References

#'Tukey JW (1957). "On the Comparative Anatomy of Transformations." *The Annals of Mathematical Statistics*, **28**(3), 602–632.

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#'Guerrero VM (1993). "Time-series analysis supported by power transformations." *Journal of Forecasting*, **12**(1), 37–48.

#'Yeo I, Johnson RA (2000). "A New Family of Power Transformations to Improve Normality or Symmetry." *Biometrika*, **87**(4), 954–959.

#'Durbin BP, Hardin JS, Hawkins DM, Rocke DM (2002). "A variance-stabilizing transformation for gene-expression microarray data." *Bioinformatics*, **18**(1), 105–110.

#'Whittaker J, Whitehead C, Somers M (2005). "The neglog transformation and quantile regression for the analysis of a large credit scoring database." *Journal of the Royal Statistical Society Series C*, **54**(4), 863–878.

#'Yang Z (2005). "A modified family of power transformations." *Economics Letters*, **92**(1), 14–19.

#'Kelmansky DM, Martinez EJ, Leiva V (2013). "A new variance stabilizing transformation for gene expression data analysis." *Statistical Applications in Genetics and Molecular Biology*, **12**(6), 653–666.

`ATA.BoxCoxAttr` *The ATA.BoxCoxAttr function works with many different types of inputs.*

Description

The ATA.BoxCoxAttr function works with many different types of inputs.

Usage

```
ATA.BoxCoxAttr(
  bcMethod = "guerrero",
  bcLower = 0,
  bcUpper = 5,
  bcBiasAdj = FALSE
)
```

Arguments

`bcMethod`	Choose method to be used in calculating lambda. "guerrero" (Guerrero, V.M. (1993) is default. Other method is "loglik").
`bcLower`	Lower limit for possible lambda values. The lower value is limited by -5. Default value is 0.
`bcUpper`	Upper limit for possible lambda values. The upper value is limited by 5. Default value is 5.
`bcBiasAdj`	Use adjusted back-transformed mean for Box-Cox transformations. If transformed data is used to produce forecasts and fitted values, a regular back transformation will result in median forecasts. If bcBiasAdj is TRUE, an adjustment will be made to produce mean forecasts and fitted values. If bcBiasAdj=TRUE. Can either be the forecast variance, or a list containing the interval `level`, the corresponding `upper` and `lower` intervals.

Value

An object of class `ataoptim`.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

#'Box GEP, Cox DR (1964). "An Analysis of Transformations." *Journal of the Royal Statistical Society. Series B (Methodological)*, **26**(2), 211–252.

#'Guerrero VM (1993). "Time-series analysis supported by power transformations." *Journal of Forecasting*, **12**(1), 37–48.

See Also

BoxCox, InvBoxCox, BoxCox.lambda

ATA.CI — *Confidence Interval function for the ATA Method*

Description

Confidence Interval function for the ATA Method

Usage

```
ATA.CI(object, ci.level = 95)
```

Arguments

`object`	An `ATA` object is required.
`ci.level`	Confidence level, for example: 90, 95 or 99.

Value

The confidence interval output for the ATA forecasts

`ATA.Core` *The core algorithm of the ATA Method*

Description

The core algorithm of the ATA Method

Usage

```
ATA.Core(X, pk, qk, phik, mdlType, initialLevel, initialTrend)
```

Arguments

`X`	A numeric vector or time series.
`pk`	Value of Level parameter.
`qk`	Value of Trend parameter.
`phik`	Value of Damping Trend parameter.
`mdlType`	An one-character string identifying method using the framework terminology.
`initialLevel`	If NULL, FALSE is default. If FALSE, ATA Method calculates the pth observation in `X` for level. If TRUE, ATA Method calculates average of first p value in `X`for level.
`initialTrend`	If NULL, FALSE is default. If FALSE, ATA Method calculates the qth observation in `X(T)-X(T-1)` for trend. If TRUE, ATA Method calculates average of first q value in `X(T)-X(T-1)` for trend.

Value

Returns an object of class "`ATA`"

`ATA.Decomposition` *Seasonal Decomposition for The ATAforecasting*

Description

Automatic seasonal decomposition for ATA Method is called `ATA.Decomposition` function in ATAforecasting package. The function returns seasonally adjusted data constructed by removing the seasonal component. The methodology is fully automatic. The `ATA.Decomposition` function works with many different types of inputs.

Usage

```
ATA.Decomposition(input, s.model, s.type, s.frequency, seas_attr_set)
```

Arguments

`input` It must be `ts` or `msts` or `numeric` object. if it is `numeric` object, `findPeriod` must be 1 or 2 or 3 or 4. if it is `msts` object, `findPeriod` must be 3 or 4.

`s.model` A string identifying method for seasonal decomposition. If NULL, "decomp" method is default. c("none", "decomp", "stl", "stlplus", "tbats", "stR") phrases of methods denote.

- none : seasonal decomposition is not required.
- decomp : classical seasonal decomposition. If `decomp`, the `stats` package will be used.
- stl : seasonal-trend decomposition procedure based on loess developed by Cleveland et al. (1990). If `stl`, the `stats` and `forecast` packages will be used. Multiple seasonal periods are allowed.
- stlplus : seasonal-trend decomposition procedure based on loess developed by Cleveland et al. (1990). If `stlplus`, the `stlplus` package will be used.
- tbats : exponential smoothing state space model with Box–Cox transformation, ARMA errors, trend and seasonal components. as described in De Livera, Hyndman & Snyder (2011). Parallel processing is used by default to speed up the computations. If `tbats`, the `forecast` package will be used. Multiple seasonal periods are allowed.
- stR : seasonal-trend decomposition procedure based on regression developed by Dokumentov and Hyndman (2015). If `stR`, the `stR` package will be used. Multiple seasonal periods are allowed.
- x13 : seasonal-trend decomposition procedure based on X13ARIMA/SEATS. If `x13`, the `seasonal` package will be used.
- x11 : seasonal-trend decomposition procedure based on X11. If `x11`, the `seasonal` package will be used.

`s.type` A one-character string identifying method for the seasonal component framework. If NULL, "M" is default. The letter "A" for additive model, the letter "M" for multiplicative model.

s.frequency	Value(s) of seasonal periodicity. If s.frequency is not integer, X must be msts time series object. c(s1,s2,s3,...) for multiple period. If X has multiple periodicity, "tbats" or "stR" seasonal model have to be selected.
seas_attr_set	Assign from ATA.SeasAttr function. Attributes set for unit root and seasonality tests. For example: period of the input data which have one seasonal pattern –> 12 for monthly / 4 for quarterly / 7 for daily / 5 for business days. periods of the input data which have complex/multiple seasonal patterns –> c(7,354.37,365.25).

Value

Seasonal components of the univariate time series. ATA.Decomposition is a list containing at least the following elements:

AdjustedX	Deseasonalized data
SeasIndex	Particular weights of seasonality given cycle/frequency
SeasActual	Seasonality given original data
SeasType	Seasonal decomposition technique

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

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See Also

`stl`, `decompose`, `seas`, `tbats`, `stlplus`, `AutoSTR`.

`ATA.Forecast` *Forecasting Method for The ATAforecasting*

Description

`ATA.Forecast` is a generic function for forecasting of the ATA Method.

Usage

```
ATA.Forecast(
  object,
  h = NULL,
  out.sample = NULL,
  ci.level = 95,
  negative.forecast = TRUE,
  print.out = TRUE
)
```

Arguments

`object`	An `ata` object is required for forecast.
`h`	Number of periods for forecasting.
`out.sample`	A numeric vector or time series of class `ts` or `msts` for out-sample.
`ci.level`	Confidence Interval levels for forecasting. Default value is 95.
`negative.forecast`	Negative values are allowed for forecasting. Default value is TRUE. If FALSE, all negative values for forecasting are set to 0.
`print.out`	Default is TRUE. If FALSE, forecast summary of ATA Method is not shown.

Value

An object of class `ata` and forecast values.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

#'Yapar G, Yavuz I, Selamlar HT (2017). "Why and How Does Exponential Smoothing Fail? An In Depth Comparison of ATA-Simple and Simple Exponential Smoothing." *Turkish Journal of Forecasting*, **1**(1), 30–39.

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See Also

`forecast`, `stlplus`, `stR`, `stl`, `decompose`, `tbats`, `seasadj`.

Examples

```
trainATA <-  head(touristTR, 84)
ata_fit <- ATA(trainATA, parPHI = 1, seasonal.test = TRUE, seasonal.model = "decomp")
ata_fc <- ATA.Forecast(ata_fit, h=12)
```

`ATA.Plot` *Specialized Plot Function of The ATAforecasting*

Description

Specialized Plot Function of The ATAforecasting

Usage

```
ATA.Plot(object, fcol = 4, flty = 2, flwd = 2, ...)
```

Arguments

`object`	an object of `ata`
`fcol`	line color
`flty`	line type
`flwd`	line width
`...`	other inputs

Value

a graphic output for the components of the ATAforecasting

`ATA.Print` *Specialized Screen Print Function of The ATAforecasting*

Description

Specialized Screen Print Function of The ATAforecasting

Usage

```
ATA.Print(object, ...)
```

Arguments

`object`	an object of `ata`
`...`	other inputs

Value

a summary for the results of the ATAforecasting

`ATA.SeasAttr` *Attributes Set For Unit Root and Seasonality Tests*

Description

This function is a class of seasonality tests using `corrgram.test` from ATAforecasting package, `ndiffs` and `nsdiffs` functions from forecast package. Also, this function is modified version of `ndiffs` and `nsdiffs` written by Hyndman et al. `forecast` package. Please review manual and vignette documents of latest `forecast` package. According to `forecast` package, `ndiffs` and `nsdiffs` functions to estimate the number of differences required to make a given time series stationary. `ndiffs` uses unit root tests to determine the number of differences required for time series to be made trend stationary. Several different tests are available:

- uroot.test = 'kpss' : the KPSS test is used with the null hypothesis that `x` has a stationary root against a unit-root alternative. Then the test returns the least number of differences required to pass the test at the level `uroot.alpha`.
- uroot.test = 'adf' : the Augmented Dickey-Fuller test is used.
- uroot.test = 'pp' : the Phillips-Perron test is used. In both of these cases, the null hypothesis is that `x` has a unit root against a stationary root alternative. Then the test returns the least number of differences required to fail the test at the level `alpha`.

`nsdiffs` uses seasonal unit root tests to determine the number of seasonal differences required for time series to be made stationary. Several different tests are available:

- suroot.test = 'seas' : a measure of seasonal strength is used, where differencing is selected if the seasonal strength (Wang, Smith & Hyndman, 2006) exceeds 0.64 (based on minimizing MASE when forecasting using auto.arima on M3 and M4 data).
- suroot.test = 'ch' : the Canova-Hansen (1995) test is used (with null hypothesis of deterministic seasonality)
- suroot.test = 'hegy' : the Hylleberg, Engle, Granger & Yoo (1990) test is used.
- suroot.test = 'ocsb' : the Osborn-Chui-Smith-Birchenhall (1988) test is used (with null hypothesis that a seasonal unit root exists).
- suroot.test = 'correlogram' : this function is written based on M4 Competition Seasonality Test.

Usage

```
ATA.SeasAttr(
  corrgram.tcrit = 1.28,
  uroot.test = "adf",
  suroot.test = "correlogram",
  suroot.uroot = TRUE,
  uroot.type = "level",
  uroot.alpha = 0.05,
  suroot.alpha = 0.05,
  uroot.maxd = 2,
  suroot.maxD = 1,
  suroot.m = NULL,
  uroot.pkg = "tseries",
  multi.period = "min",
  x13.estimate.maxiter = 1500,
  x13.estimate.tol = 1e-05,
  x11.estimate.maxiter = 1500,
  x11.estimate.tol = 1e-05
)
```

Arguments

`corrgram.tcrit`	t-value for autocorrelogram.
`uroot.test`	Type of unit root test before all type seasonality test. Possible values are "adf", "pp" and "kpss".
`suroot.test`	Type of seasonal unit root test to use. Possible values are "correlogram", "seas", "hegy", "ch" and "ocsb".
`suroot.uroot`	If TRUE, unit root test for stationary before seasonal unit root test is allowed.
`uroot.type`	Specification of the deterministic component in the regression for unit root test. Possible values are "level" and "trend".
`uroot.alpha`	Significant level of the unit root test, possible values range from 0.01 to 0.1.

`suroot.alpha`	Significant level of the seasonal unit root test, possible values range from 0.01 to 0.1
`uroot.maxd`	Maximum number of non-seasonal differences allowed.
`suroot.maxD`	Maximum number of seasonal differences allowed.
`suroot.m`	Deprecated. Length of seasonal period: frequency of data for nsdiffs.
`uroot.pkg`	Using `urca` or `tseries` packages for unit root test. The default value is "urca".
`multi.period`	Selection type of multi seasonal period. `min` or `max` function for selection
`x13.estimate.maxiter`	Maximum iteration for X13ARIMA/SEATS estimation
`x13.estimate.tol`	Convergence tolerence for X13ARIMA/SEATS estimation
`x11.estimate.maxiter`	Maximum iteration for X11 estimation
`x11.estimate.tol`	Convergence tolerence for X11 estimation

Value

An object of class `ataoptim`.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

See Also

`forecast`, `stlplus`, `stR`, `stl`, `decompose`, `tbats`, `seasadj`.

`ATA.Seasonality` *Seasonality Tests for The ATAforecasting*

Description

This function is a class of seasonality tests using `corrgram_test` from ATAforecasting package, `ndiffs` and `nsdiffs` functions from forecast package. Also, this function is modified version of `ndiffs` and `nsdiffs` written by Hyndman et al. `forecast` package. Please review manual and vignette documents of latest `forecast` package. According to `forecast` package, `ndiffs` and `nsdiffs` functions to estimate the number of differences required to make a given time series stationary. `ndiffs` uses unit root tests to determine the number of differences required for time series to be made trend stationary. Several different tests are available:

- uroot.test = 'kpss' : the KPSS test is used with the null hypothesis that `x` has a stationary root against a unit-root alternative. Then the test returns the least number of differences required to pass the test at the level `uroot.alpha`.
- uroot.test = 'adf' : the Augmented Dickey-Fuller test is used.

- uroot.test = 'pp' : the Phillips-Perron test is used. In both of these cases, the null hypothesis is that `x` has a unit root against a stationary root alternative. Then the test returns the least number of differences required to fail the test at the level `uroot.alpha`.

`nsdiffs` uses seasonal unit root tests to determine the number of seasonal differences required for time series to be made stationary. Several different tests are available:

- suroot.test = 'seas' : a measure of seasonal strength is used, where differencing is selected if the seasonal strength (Wang, Smith & Hyndman, 2006) exceeds 0.64 (based on minimizing MASE when forecasting using auto.arima on M3 and M4 data).
- suroot.test = 'ch' : the Canova-Hansen (1995) test is used (with null hypothesis of deterministic seasonality)
- suroot.test = 'hegy' : the Hylleberg, Engle, Granger & Yoo (1990) test is used.
- suroot.test = 'ocsb' : the Osborn-Chui-Smith-Birchenhall (1988) test is used (with null hypothesis that a seasonal unit root exists).
- suroot.test = 'correlogram' : this function is written based on M4 Competition Seasonality Test.

Usage

```
ATA.Seasonality(input, ppy, attr_set)
```

Arguments

`input`	The data.
`ppy`	Frequency of the data.
`attr_set`	Assign from `ATA.SeasAttr` function. Attributes set for unit root, seasonality tests.

Value

`TRUE` if the serie has seasonality. Otherwise, `FALSE`.

Author(s)

Ali Sabri Taylan and Hanife Taylan Selamlar

References

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#'Kwiatkowski D, Phillips P, Schmidt P, Shin Y (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?" *Journal of Econometrics*, **54**(1–3), 159–178.

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#'Wang X, Smith KA, Hyndman RJ (2006). "Characteristic-based clustering for time series data." *Data Mining and Knowledge Discovery*, **13**(3), 335–364.

See Also

`forecast`, `urca`, `tseries`, `uroot`, `stlplus`, `stR`, `stl`, `decompose`, `tbats`, `seasadj`.

`ATA.Shift` *Lag/Lead (Shift) Function for Univariate Series*

Description

Lag/Lead (Shift) Function for Univariate Series

Usage

```
ATA.Shift(x, shift_by, fill = NA)
```

Arguments

`x`	given vector
`shift_by`	lag or lead parameter
`fill`	a value to be used to fill the rows

Value

Generating a lag/lead variables

ATA.Shift_Mat *Lag/Lead (Shift) Function for Multivariate Series*

Description

Lag/Lead (Shift) Function for Multivariate Series

Usage

```
ATA.Shift_Mat(X, direction = "down", shift_by = 1, fill = NA)
```

Arguments

X	given matrice
direction	direction of shifting. Default is "down".
shift_by	number of rows to be shifed upwards/downwards
fill	a value to be used to fill the rows

Value

Generating a lag/lead matrice

ATA.Transform *Transformation Techniques for The ATAforecasting*

Description

The function provides the applicability of different types of transformation techniques for the data to which the Ata method will be applied. The ATA.Transform function works with many different types of inputs.

Usage

```
ATA.Transform(
  X,
  tMethod = c("Box_Cox", "Sqrt", "Reciprocal", "Log", "NegLog", "Modulus",
    "BickelDoksum", "Manly", "Dual", "YeoJohnson", "GPower", "GLog"),
  tLambda,
  tShift = 0,
  bcMethod = c("loglik", "guerrero"),
  bcLower = 0,
  bcUpper = 5
)
```

Arguments

`X`	a numeric vector or time series of class `ts` or `msts` for in-sample.
`tMethod`	Box-Cox power transformation family is consist of "Box_Cox", "Sqrt", "Reciprocal", "Log", "NegLog", "Modulus", "BickelDoksum", "Manly", "Dual", "YeoJohnson", "GPower", "GLog" in ATAforecasting package. If the transformation process needs shift parameter, `ATA.Transform` will calculate required shift parameter automatically.
`tLambda`	Box-Cox power transformation family parameter. If NULL, data transformed before model is estimated.
`tShift`	Box-Cox power transformation family shifting parameter. If NULL, data transformed before model is estimated.
`bcMethod`	Choose method to be used in calculating lambda. "loglik" is default. Other method is "guerrero" (Guerrero, V.M. (1993)).
`bcLower`	Lower limit for possible lambda values. The lower value is limited by -5. Default value is 0.
`bcUpper`	Upper limit for possible lambda values. The upper value is limited by 5. Default value is 1.

Value

A list object consists of transformation parameters and transformed data. `ATA.Transform` is a list containing at least the following elements:

- trfmX : Transformed data
- tLambda : Box-Cox power transformation family parameter
- tShift : Box-Cox power transformation family shifting parameter

References

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`find.freq` *Find Frequency Using Spectral Density Of A Time Series From AR Fit*

Description

Find Frequency Using Spectral Density Of A Time Series From AR Fit

Usage

```
find.freq(x)
```

Arguments

`x`	an univariate time series

Value

frequency/cycle of the given time data

`find.freq.fourier` *Find Frequency Using Periodogram*

Description

Find Frequency Using Periodogram

Usage

```
find.freq.fourier(x)
```

Arguments

`x`	an univariate time series

Value

frequency/cycle of the given data

`find.multi.freq` *Find Multi Frequency Using Spectral Density Of A Time Series From AR Fit*

Description

Find Multi Frequency Using Spectral Density Of A Time Series From AR Fit

Usage

```
find.multi.freq(x)
```

Arguments

`x`	an univariate time series

Value

multi frequencies/cycles of the given data

`fundingTR` *Weekly Net Funding Level of Central Bank of Republic of Turkey*

Description

Weekly Net Funding Level of Central Bank of Republic of Turkey: from Jan 7, 2011 to Jan 08, 2021.

Usage

```
data(fundingTR)
```

Format

Time series data

Source

The Central Bank of the Republic of Turkey – CBRT.

Examples

```
plot(fundingTR)
```

touristTR *Monthly number of tourists arrived in Turkey*

Description

Monthly number of tourists arrived in Turkey: from Jan 2008 to Dec 2020.

Usage

```
data(touristTR)
```

Format

Time series data

Source

The Central Bank of the Republic of Turkey – CBRT.

Examples

```
plot(touristTR)
```

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